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(71)(72) Applicant and Inventor: ROSENCWAIG, Allan [US/US]; 3304 Deer Hollow Drive, Danville, CA 94506 (US).

(74) Agents: HAVERSTOCK, Thomas, B. et al.; Haverstock, Medlen & Carroll, Suite 2200, 220 Montgomery Street, San Francisco, CA 94104 (US).

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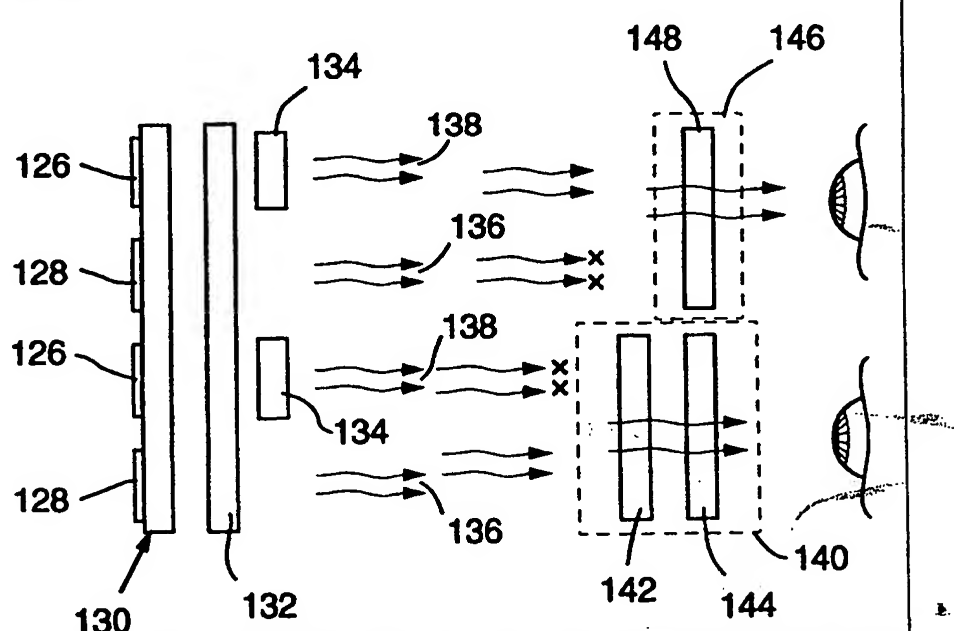

(57) Abstract

A first stereoscopic vision system for a raster displayed image includes two sets of passive filters. A first set of passive filters is associated with the display. In the preferred embodiment, the image from alternate rows of pixels (126, 128) are transmitted through oppositely oriented polarizers (134), such that odd numbered rows are transmitted through polarizers having a first polarity and even numbered rows are transmitted through polarizers having a second polarity. The image intended for each eye is displayed through only a polarizer having either the first or second polarity but not both (146, 148). The polarizer filters for the display are formed through photolithographic techniques. Each of the viewer's eyes has an appropriately corresponding polarizing filter positioned between it (but not the other eye) and the screen. In this way only the image that is intended for each eye can reach the appropriate eye.

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STEREOSCOPIC VISION SYSTEM

Field of the Invention

This invention relates to the field of generating and displaying stereoscopic images to a human viewer. More particularly, this invention relates to systems wherein only passive stereoscopic filters are employed.

Background of the Invention

In everyday life, viewers look at physical objects and see them stereoscopically. As a viewer looks at objects, he receives a visual image in each eye. Because of the distance between the viewer's two eyes, the image seen by each eye is not identical. The brain processes the signals received from each eye and integrates the information into a perceived stereoscopic image.

Inherent in being able to see objects in true stereoscopic form is that each eye sees a slightly different view of the same object foreseen. Because of this, images commonly displayed on two-dimensional viewing screens (movie theaters, televisions, or computer monitors) are not presented in stereoscopic form. Because a single two-dimensional representation of a three dimensional object is displayed, each eye necessarily sees the identical image. Accordingly, the brain does not receive sufficient information to process a true stereoscopic scene.

Note that a stereoscopic image is interpreted by the viewer as a true three-dimensional image. This is in contrast to the so-called "three-dimensional" images generated by computer programs such as they are used in Computer-Aided Design (CAD) systems. These images are three-dimensional representations of two-dimensional images rather than the true three-dimensional images generated by a stereoscopic system.

Practitioners have attempted a variety of approaches to present stereoscopic images to the viewer's eyes from

a two-dimensional display. Most systems require the viewer to wear a pair of glasses of some sort. For example, stereoscopic movies have presented two images on the same screen to the viewers. Looking at the screen with an unaided eye presents blurry or confusing images to the viewer. Usually, each of the images is presented in different colors. The viewer wears a pair of glasses with two differently colored lenses to filter only the appropriate image to each eye. In this way, the scene intended for the left eye is only presented to the left eye while the scene intended for the right eye is appropriately transmitted. While relatively inexpensive, because of problems associated with color matching, color saturation of the vision system, and other factors, these color stereoscopic systems are extremely tiring, confusing and irritating to the average viewer.

Another approach (U.S. Patent 4,744,633) includes presenting two side by side images possibly from two different displays. The viewer wears a pair of glasses with appropriate beam bending characteristics to properly present the two images to the viewer's eyes to allow the brain to process a true stereoscopic image. While workable in theory, such systems are complex and expensive due to the necessary optics to appropriately bend the rays and the possible need for two display units.

In yet another approach (U.S. Patent 2,783,406) for use with a television system, two separate electron guns are each provided with the signals to generate a separate left and right image. The gun signals are interlaced onto a lenticulated screen which has the appropriate optics to present the appropriate image to each of the viewer's eyes without the use of special glasses. This system is however severely limited by the fact that the viewer must be positioned at an appropriate location relative to the lenticulated screen.

With the advent of rapid light shutters using liquid crystal technology, other systems for displaying stereoscopic images became possible. In one system, the images for the left and right eye are alternatively displayed during alternate screen refresh cycles. The viewer wears a pair of active glasses which synchronously and alternately occlude and open the liquid crystal lenses, thereby selecting the appropriate image for the appropriate eye. However, in normal displays, once written, the image for each pixel tends to persist until rewritten. Thus, while the screen is beginning to display the image for one eye at the upper part of the screen, the screen continues to display the image for the other eye at the lower part of the screen until that portion of the display has been written. Accordingly, there are ghost images displayed. In addition power and control electronics need to be provided to these active glasses.

Other inventors (U.S. Patent 4,719,507) have tried systems alternately displaying the left and right images using active liquid crystal filters at the display for alternatively presenting the appropriate image to the appropriate eye via mutually exclusive passive filters in each lens of a pair of glasses. As with the active liquid crystal glasses, such systems also have a ghost image problem and require additional power and control electronics to operate the active display filters. In addition, if such systems operate at standard screen refresh rates, each eye will receive its image half as often and receive no image half the time. Accordingly, either the viewer experiences a flickering image or a specially designed faster display device must be used.

Systems employing active liquid crystal filters at either the display or in the viewing glasses present higher quality stereoscopic images than do the older passive systems. Unfortunately, such systems also present ghost images. Further, commercially available

active systems are very expensive and thus have a limited utility for mass market sales and use.

Therefore, it is one object of the subject invention to provide an improved method for stereoscopic display systems that eliminates the problem of ghost images.

It is a further object of the subject invention to provide an improved method for stereoscopic display systems that produce high quality stereoscopic images but at much lower cost than current active stereoscopic devices.

It is still a further object of the subject invention to provide an improved method for stereoscopic display systems that employ purely passive filter means, thereby eliminating the power and control electronics needed for active systems.

Another object of the subject invention is to provide a method for providing stereoscopic imaging for a large variety of displays: CRT's, LCD's, plasma, etc.

It is a further object of the subject invention to provide a relatively simple method to manufacture the patterned display filters of this subject invention using photolithographic means.

Another aspect of the subject invention is to further simplify the manufacture of the patterned display filters by using the display itself to generate the photolithographic mask, or even to generate the pattern in the display filter directly.

Summary of the Invention

In accordance with these and other objects, the subject invention relates to a passive stereoscopic vision system for a raster displayed image that includes two sets of passive filters. A first set of passive filters is associated with the display. In the preferred embodiment, the image from alternate rows of pixels are transmitted through oppositely oriented polarizers, such that odd numbered rows are transmitted through polarizers

having a first polarity and even numbered rows are transmitted through polarizers having a second polarity. The image intended for each eye is displayed through only a polarizer having either the first or the second polarity but not both. The polarizer filters for the display are formed through photolithographic techniques. Each of the viewer's eyes has an appropriately corresponding polarizing filter positioned between it (but not the other eye) and the screen. In this way only the image that is intended for each eye can reach the appropriate eye.

Brief Description of the Drawings

Figure 1 shows a perspective overview illustration of the preferred embodiment of the present invention.

Figure 2 shows a close-up view of a portion of the display screen of the preferred embodiment.

Figure 3 shows a close-up view of a portion of the display screen of an alternate embodiment.

Figure 4 shows a sectional schematic view of an alternate embodiment.

Figure 5 shows a sectional schematic view of the preferred embodiment of the present invention.

Figures 6A through 6K show cross section views of a method for manufacturing the display screen filter.

Figures 7A through 7F show cross section views of the preferred method for manufacturing the display screen filter.

Detailed Description of the Preferred Embodiment

Figure 1 shows a perspective overview of the preferred embodiment of the present invention. A raster based display screen 100 presents two images of an object. Each image is presented from a slightly different perspective, i.e., the perspective of each of the two eyes of a typical viewer.

The two images are interlaced on the display. In Figure 1, the image shown on the screen is a cube. The image is broken to represent the two interlaced images of the cube. The representation of Figure 1 is merely suggestive of this feature of the invention. The cube is shown as broken portions of two interlaced cubes 102 and 104 shown from two slightly different perspectives. In contrast, in the preferred embodiment, the two images are displayed on alternate rows. By way of example, the image intended for the left eye is displayed on the even rows and the image intended for the right eye is displayed on odd rows. The selection of odd and even rows could just as easily have been selected oppositely.

The raster display 100 can be either a CRT, liquid crystal or other type of display. The displays can be treated as a set of pixels arrayed in rows and columns.

A viewer 106 wears a pair of glasses 108, having two oppositely polarized lenses 110 and 112, one for each eye, each of which selectively transmit only the appropriate image from the appropriate alternate rows. In this way, only the image intended for each eye is transmitted to that eye. Further, because the images for each eye are interlaced and continuously displayed there is no image switching from eye to eye and there are no ghost images. Furthermore, if the refresh rate for each frame is high enough, there will also be no flicker.

Figure 2 shows a close-up of a portion of the display screen 100 (Figure 1). The even rows 114 are provided with polarizers having a first orientation and the odd rows 116 are provided with polarizers having a second orientation. It is also possible to have alternate pixels or groups of pixels associated with the image for each eye as shown in Figure 3. In the alternate embodiment of Figure 3, a first set of pixels 120 shown as open circles are associated with the left eye image and a second set of pixels 122 shown as filled circles are associated with the right eye image. That

is, the stereoscopic image can be formed by interlacing alternate pixels or sets of pixels or alternate rows or in any other interlaced fashion.

In Figure 4, a portion of a display screen 130 is shown including 2 pixels 126 and 2 others 128. The light emanating from all the pixels is transmitted through the screen 130 to the display filter which includes a linearizing polarizer 132 and a birefringent retarder 154 in front of alternate pixels 126. The display filter in front of pixels 128 includes only the linearizing polarizer 132. The retarder 154 is adapted to rotate the polarization of the light from pixels 126 by 90° by means of providing a positive half-wave retardation (+ $\lambda/2$).

A pair of glasses is positioned over the viewer's eyes including two lenses 140 and 146. The first lens 140 consists of a birefringent retarder 142 that rotates the polarization of light striking lens 140 by -90° by means of providing a negative half-wave retardation (-$\lambda/2$). The retarder 142 is followed by a linearizing polarizer 144 oriented at 90° relative to the display polarizer 132. The second lens 146 includes simply a linearizing polarizer 148 that is also oriented at 90° relative to the display polarizer 132.

Though the lenses 140 and 146 of the glasses are shown one on top of the other in Figure 4, this is for representational purposes only. It will be apparent to one of ordinary skill in the art that the lenses will appear side by side in a glasses frame in the ordinary manner.

The transmission of light through the glasses can be calculated as follows. Assume that the thickness of the birefringent retarder is such that the retardation Δ is precisely +$\lambda/2$ at 500nm. Because the amount of retardation is a function of wavelength such that $\Delta = (n_e - n_o)t$; where n_e and n_o are the refractive indices for the slow and fast axes in the birefringent material, Δ is different for different wavelengths, such that:

$$\Delta(\lambda) = \lambda/2 + \delta(\lambda)$$

where $\delta(\lambda) = 0$ at $\lambda = 500$nm. Similarly, for $-\lambda/2$

$$\Delta(\lambda) = -\lambda/2 - \delta(\lambda)$$

The net retardation from the filter at the display Δ_d and the filter at the glasses Δ_g is shown by:

$$(\Delta_d + \Delta_g)$$

To understand how the stereoscopic separation is achieved by means of these display and viewer filters, we calculate the net retardation of light through the display and viewer filters $(\Delta_d + \Delta_g)$. If the net retardation is zero then the viewer filters will block the light since the linearizing polarizer in the viewer filters are set at 90° relative to the linearizing polarizer at the display. On the other hand, the glasses will completely transmit that light which undergoes a net retardation of half-wave (+ or - $\lambda/2$) since this light will then undergo a 90° rotation of polarization.

We thus have four possible combinations for net retardation.

$$\Delta_d(0) + \Delta_g(0) = 0 + 0 = 0$$

$$\Delta_d(+\lambda/2) + \Delta_g(-\lambda/2) = +\lambda/2 + \delta(\lambda) - \lambda/2 - \delta(\lambda) = 0$$

$$\Delta_d\ (0) + \Delta_g(-\lambda/2) = 0 - \lambda/2 - \delta(\lambda) = -\lambda/2 - \delta(\lambda)$$

$$\Delta_d(+\lambda/2) + \Delta_g(0) = +\lambda/2 + \delta(\lambda) + 0 = +\lambda/2 + \delta(\lambda)$$

Thus light from pixels 128 will be blocked by viewer lens 146 and light from pixels 126 will be blocked by lens 140. Note that the light at any wavelength will be completely blocked as long as the birefringent materials

used in the display and viewer filters are well matched. Examining the last two equations, we can see that light from pixels 128 will be transmitted by viewer lens 140, and light from pixels 126 will be transmitted by viewer lens 146. Although the net retardation and thus the amount of light transmitted will vary with wavelength, the transmission will be the same for both lenses as long as the birefringent material in the viewer lens is well matched to that in the display filter.

So long as the viewer holds the glasses so that the linear polarizers 144 and 148 in the glasses (Figure 4) are perpendicular to the linear polarizer 132 in the display filter, this system will prevent displaying the left image to the right eye and vice versa. Unfortunately, as the viewer's head is tilted, there will be degradation in the stereo separation and "cross-talk" will result between the separate images and the viewer's eyes.

To overcome this deficiency, the light is encoded and decoded using circularly polarized light. At the display, the light from the array of pixels is first linearly polarized and that light is selectively circularly polarized. In the viewer glasses, each lens selectively circularly polarizes the light received from the display to return it to linearly polarized light. That light is then applied to linear polarizers to selectively pass or block that light.

In Figure 5, a portion of the display screen 130 is shown including two alternate pixels 126 and two other alternate pixels 128. The light emanating from the pixels is transmitted through the screen 130 to the display filter including a linearizing retarder 132 and birefringent retarders 154 and 156. The birefringent retarder 154 is adapted to circularly rotate the polarization of the light by means of a positive quarter-wave retardation ($+\lambda/4$) thereby generating right-hand circularly polarized light. The birefringent retarder

156 is adapted to oppositely circularly rotate the polarization of the light by means of a negative quarter-wave retardation ($-\lambda/4$) thereby generating left-hand circularly polarized light.

A pair of glasses is positioned over the viewer's eyes including two lenses 150 and 156. The light emanating from the display filter strikes a birefringent retarder 152 in the first lens 150 which is adapted to generate right-hand circularly polarized light by means of a positive quarter-wave retardation ($+\lambda/4$). The light passed by the birefringent retarder 152 then strikes a linearizing polarizing 154. The linearizing polarizer 154 is oriented 90° out of phase with the linearizing polarizer 132 in the display filter.

The light emanating from the display filter also strikes a birefringent retarder 158 in the second lens 156 which is adapted to generate left-hand circular polarized light by means of a negative quarter-wave retardation by ($-\lambda/4$). The light passed by the birefringent retarder 158 then strikes a linearizing polarizer 160. The linearizing polarizer 160 is also oriented 90° out of phase with the linearizing polarizer 132 in the display filter.

The net retardation from the filter at the display Δ_d and the filter at the glasses Δ_g is shown by:

$$(\Delta_d + \Delta_g)$$

A portion of the light will be blocked as mathematically described by:

$$\Delta_{d(+\lambda/4)} + \Delta_{g(-\lambda/4)} = +\lambda/4 + ½\delta(\lambda) - \lambda/4 - ½\delta(\lambda) = 0, \text{ and}$$

$$\Delta_{d(-\lambda/4)} + \Delta_{g(+\lambda/4)} = -\lambda/4 - ½\delta(\lambda) + \lambda/4 + ½\delta(\lambda) = 0.$$

Thus, light which passes through a birefringent retarder at the display screen having a first rotational sense

will be totally blocked by the glasses lens which has a birefringent retarder of the opposite sense.

Similarly, the light will appropriately be transmitted through the complementary lenses as described by:

$$\Delta_{d(+\lambda/4)} + \Delta_{g(+\lambda/4)} = +\lambda/4 + \tfrac{1}{2}\delta(\lambda) + \lambda/4 + \tfrac{1}{2}\delta(\lambda)$$
$$= +\lambda/2 + \delta(\lambda), \text{ and}$$

$$\Delta_{d(+\lambda/4)} + \Delta_{g(-\lambda/4)} = -\lambda/4 - \tfrac{1}{2}\delta(\lambda) - \lambda/4 - \tfrac{1}{2}\delta(\lambda)$$
$$= -\lambda/2 - \delta(\lambda).$$

Thus, light which passes through a birefringent retarder at the display screen having a first rotation sense will be transmitted through the glasses lens which has a birefringent retarder of the same sense.

Note, similar viewer glasses have been described in U.S. Patent 4,719,507 although these were used with active liquid crystal display filters.

Commercially available LCD displays already include a linearizing polarizer such as indicated by reference numeral 132 in Figures 4 and 5. Thus, for LCD displays an additional linearizing polarizer is not necessary. Commercially available CRT displays rarely include a linearizing polarizer and as such will generally require one for implementing the present invention.

As is well known, the location of each pixel in an LCD display is fixed relative to the physical dimension of the display screen due to the process for manufacturing the display. In contrast, the pixel location on a CRT display is variable depending upon the calibration of the voltage applied to control the electron gun. The voltage must remain fixed to within $\approx 0.05\%$ for a typical 480 line raster in order to appropriately use the passive filter concept of the present invention.

The level of voltage control in color CRTs is sufficiently stable to allow the gun to accurately strike the shadow mask for forming a desired color Such control should be adequate for controlling the electron gun for use with the present invention. In the event that more control is desired, an active feedback circuit can be used to more accurately control the electron gun voltage.

The polarizing filters with selective patterns are not commercially available and need to be manufactured to provide the advantages of the present invention. Both linearizing polarizers and birefringent retardation plates are available as polymer sheets. Such polymer sheets are produced by and available from the Polaroid Corporation and other companies.

First let us consider the manufacture of patterned display filters that generate alternate patterns of orthogonally linear polarized light. Preferably, a substrate 200 of glass or plastic is provided which is transparent to light in the frequencies needed for the LCD or CRT displays (Figure 6A). However, there may exist polarizing polymer sheets having the appropriate optical characteristics which are sufficiently stiff to obviate the need for a substrate. For a CRT display or other display without an integral linearizing polarizer, a thin layer of a transparent index matching adhesive 202 is applied to the substrate (Figure 6B) and a linearizing polarizer 204 is then affixed to the transparent index matching adhesive 202 (Figure 6C) such that the orientation of the polarizer is known relative to the substrate 200. For an LCD display having an integral linearizing polarizer, this layer of transparent index matching adhesive and the linearizing polarizer are not needed.

Next, another thin layer of a transparent index matching adhesive 206 is applied to the linearizing polarizer 204 (Figure 6D). (In the case of an LCD display with an integral linearizing polarizer, the thin

layer of a transparent index matching adhesive 206 is applied to the substrate 200.) A transparent barrier layer 208 is affixed to the transparent index matching adhesive 206 (Figure 6E). The barrier layer is provided as a readily controllable means for stopping an etching step (described in detail below). Accordingly, it may be possible to delete the transparent barrier 208 and its transparent index matching adhesive 206 by use of carefully characterized etching. In this way, the amount of etching can be selected by controlling the etch solution, the time of etching, the temperature of the etching bath and other similar techniques. All the barrier layers described below can be similarly replaced.

Another thin layer of a transparent index matching adhesive 210 is applied to the exposed surface of the transparent barrier layer 208 (Figure 6F). A birefringent retarder polymer sheet 212 is affixed to the layer of transparent index matching adhesive 210 (Figure 6G). The birefringent retarder 212 is aligned so that its fast axis is +45° to the polarization axis of the linearizing polarizer 204. (In the case of an LCD display with an integral linearizing polarizer, the birefringent retarder 212 is aligned so that its fast axis is +45° to the polarization axis of the integral linearizing polarizer.) In addition, the birefringent retarder 212 is conditioned to provide $+\lambda/4$ (quarter wave) retardation at 500nm. In commercially available birefringent retarders the amount of retardation is a function of the thickness of the polymer film.

The sheet of birefringent retarder 212 is to be patterned to match the pixel row structure, or other alternating pixel configuration. Photolithography is a convenient means for patterning the sheet of birefringent retarder 212. A layer of a suitable photoresist 214 is deposited onto the surface of the birefringent retarder 212 (Figure 6H).

In the usual manner, a mask is aligned to the structure of Figure 6H which is then exposed to an appropriate light source and subsequently patterned in a wash. The patterned photoresist layer is used as a mask for etching the birefringent retarder 212 for forming a patterned birefringent polarizer layer 220A (Figure 6I). The underlying transparent index matching adhesive 210 is also etched. Either a wet chemical etch or a dry plasma etch can be used. The etch is selected such that it will etch away the birefringent material and the index matching adhesive but will not etch the barrier layer material. In Figure 6I, the structure is that of simple rows. However, it is also possible to use patterns that are somewhat more complex, e.g., alternate pixels, sets of pixels, etc.

After the etching process, a layer of a transparent index matching adhesive 216 is applied to cover the patterned birefringent retarder layer 212A for forming a smooth upper surface for the structure (Figure 6J). To avoid void or empty regions, it may be desirable to spray the transparent index matching adhesive on in a fine mist, or heat it so it flows readily. Lastly, a transparent cap layer of glass or plastic is affixed over the layer of transparent index matching adhesive (Figure 6K).

Now let us consider how to manufacture patterned polarizing display filters that generate alternate patterns of right- and left-circularly polarized light.

We follow the previously described process up through the transparent index matching layer 206 (Figure 6D). Onto this layer we affix a first birefringent retarder polymer sheet 220 (Figure 7A). The birefringent retarder 220 is aligned so that its fast axis is + 45° to the polarization axis of the linearizing polarizer 204 (or + 45° to the polarization axis of the integral linearizing polarizer of an LCD display). In addition the first birefringent retarder polymer sheet 220 is

conditioned to divide + λ/4 (quarter-wave) retardation at a nominal wavelength such as 500mm.

Next another thin layer of transparent index matching adhesive 222 is affixed to the exposed surface of the first birefringent retarder 220 (Figure 7B). A transparent barrier layer 224 is affixed to the transparent index matching adhesive 222 (Figure 7C).

Another thin layer of transparent index matching adhesive 226 is affixed to the exposed surface of the barrier layer 224 (Figure 7D). A second birefringent retarder polymer sheet 228 is affixed to the layer of transparent index matching adhesive 226 (Figure 7E). The birefringent retarder 228 is aligned so that its fast axis is -45° to the polarizing axis of the linearizing polarizer 204 (or at -45° to the polarization axis of the integral linearizing polarizer of an LCD display). In addition the second birefringent retarder 228 is conditioned to provide -λ/2 (negative half-wave) retardation at the nominal wavelength of 500mm. Because the amount of retardation is a function of the thickness of the polymer sheet, this sheet is shown to be twice as thick as the + λ/4 birefringent retarder 220.

The second birefringent retarder 228 is to be patterned to match the alternate pixel row structure, or other alternating pixel configuration. We employ the same photolithographic method described before and end up with a final patterned structure shown in Figure 7F where 228A and 226A are the patterned sections of second birefringent retarder 228 and underlying index matching adhesive 226 respectively, 230 is the fill-in index matching adhesive and 232 is the transparent cover cap layer.

It is possible that the mask described above can be formed on a display screen of a similar design to the one for which the polarizing filters are being prepared. A chrome covered mask substrate can be coated with a photoresist layer and placed over the display screen. By

selectively displaying those pixels for one of the two interlaced images (left or right) the photoresist on the mask is exposed. The appropriate portions of the chrome layer can be removed. In this way, calculation of the placement of the geometries on the mask can be avoided.

In another embodiment, the polarizing filter structures described above can be formed without any mask. Rather, the layers can be formed *in situ*. Once a photoresist layer is formed on the structure, the display can be activated to expose the photoresist. Though precise alignment is necessarily obtained using this method, special care must be taken to avoid damaging the display and its associated electronics during the processing steps.

It is also possible to remove portions of the first birefringent retarder 220 and alternate portions of the second birefringent retarder 228. In such a system, the second birefringent polarizer 228 would be replaced with one that rotates the light by $-\lambda/4$. An additional masking sequence would be required. However, by following the preferred embodiment and rotating all of the light forward by $+\lambda/4$ and reverse rotating only a portion of the light by $-\lambda/2$, only a single masking sequence is needed.

It is preferred that the image presented to the viewer be free of any flicker to avoid irritating the viewer. Updating the screen image 60 times a second provides essentially flicker-free images to the average viewer. Most LCD screens and some CRT screens operate in a 60Hz non-interlaced mode. In other words, the entire screen is updated every cycle, 60 times a second. (An interlaced mode screen, such as a standard TV display, updates the even rows and then the odd rows alternately. Note the distinction between having the display interlaced and two images interlaced as with the present invention.)

For using a 60Hz non-interlaced screen with the present invention, one should interlace and load the two images into the bit map. The image for the right eye and the image for the left eye are continuously updated to the screen at a 60Hz rate, thus providing a flicker-free stereoscopic image to both eyes.

In a typical 30Hz interlaced mode format display, as in broadcast TV, the screen is divided into two fields of odd and even rows. Each field is updated 30 times a second so that the entire image is updated 60 times a second and so appears to be without flicker. If the left and the right images are interlaced onto alternate rows, then the left and right images are only updated 30 times a second and flicker will likely result. To overcome this occurrence, it is possible to double the rate of the display screen. Another approach is to interlace the images in vertical columns or a checkerboard pattern as shown in Figure 3 using appropriate electronic means to interlace the two stereoscopic images transmitted to the display.

While the subject invention has been described with reference to a number of preferred embodiments, various changes and modifications can be made therein, by one skilled in the art, without varying from the scope and spirit of the subject invention as defined by the appended claims.

C L A I M S

What is claimed is:

1. A passive stereoscopic vision system for displaying a scene to a viewer having a left eye and a right eye, the system comprising:
   a. means for interlacing and displaying a first image and a second image of a scene on a display screen from two different views;
   b. passive first means positioned for receiving light from the screen for selectively polarizing the first image differently from the second image; and
   c. passive second means for selectively blocking the first image from one of the viewer's eyes and selectively blocking the second image from other viewer's eye.

2. The system according to claim 1 wherein the passive second means is mounted in viewer worn glasses.

3. The system according to claim 2 wherein the passive first means further comprises:
   a. a first linearizing polarizer positioned to receive the first image and the second image from the display screen; and
   b. means for rotating a polarization of the light from the first image relative to the second image.

4. The system according to claim 3 wherein the glasses further comprise two lenses, one lens for each eye such that each lens includes an appropriate complementary rotational polarizer and a second linearizing polarizer.

5. The system according to claim 2 wherein the display screen incorporates an integral linearizing polarizer and further wherein the first passive means further comprises

means for rotating a polarization of the light from the first image relative to the second image.

6. The system according to claim 5 wherein the glasses further comprises two lenses, one lens for each eye such that each lens includes an appropriate complementary rotational polarizer and a second linearizing polarizer.

7. A passive stereoscopic vision system for displaying a scene to a viewer having a left eye and a right eye, the system comprising:

a. a display screen for displaying as light a first image of the scene and a second image of the scene from a different view wherein the first image and the second image are interlaced and simultaneously displayed;

b. a first linearizing polarizer positioned to receive the first image and the second image from the display screen; and

c. means for rotating a polarization of the light from the first image and the second image relative to one another.

8. The system according to claim 7 further comprising a pair of passive stereoscopic glasses comprising a first lens and a second lens wherein the first lens includes a second linearizing polarizer and the second lens includes a third linearizing polarizer such that the first lens includes an appropriately oriented means for rotating a polarization of the light that the second linearizing polarizer blocks the first image and the second lens includes an appropriately oriented means for rotating a polarization of the light that the third linearizing polarizer blocks the second image.

9. The system according to claim 8 wherein first linearizing polarizer is oriented 90° out of phase from

both the second linearizing polarizer and the third linearizing polarizer.

10. The system according to claim 9 wherein the means for rotating the polarization of the light from the first image and the second image relative to one another rotates the polarization of the light from the first image by 90° and the second image by zero.

11. The system according to claim 10 wherein the first lens rotates the polarization of the light it receives by zero and the second lens rotates the polarization of the light it receives by -90°.

12. The system according to claim 9 wherein the means for rotating the polarization of the light from the first image and the second image relative to one another rotates polarization of the light from the first image to right-hand circular polarization and rotates the polarization of the light from the second image to left-hand circular polarization.

13. The system according to claim 12 wherein the first lens rotates the polarization of the light it receives to left-hand circular polarization and the second lens rotates the polarization of the light it receives to right-hand circular polarization.

14. A passive stereoscopic vision system for displaying a scene to a viewer having a left eye and a right eye, the system comprising:

a. a raster arrayed display screen having a plurality of pixels;

b. means for interlacing and displaying as light on the display screen a first image and a second image of a scene from two different views;

c. a display filter for polarizing the first image and the second image comprising:

(1) a linear polarizer for linearly polarizing the light from the first image forming a linearly polarized first image and for linearly polarizing the light from the second image forming a linearly polarized second image; and

(2) first rotating means for selectively rotating a polarization of the linearly polarized first image differently from a polarization of the linearly polarized second image for forming a first image display output and a second image display output; and

d. a viewer filter comprising:

(1) a first lens for one of the viewer's eyes comprising:

(a) second rotating means for selectively rotating the polarization of the light from the first image display output and the second image display output forming a first lens intermediate output; and

(b) a second linear polarizer for linearly polarizing the first lens intermediate output wherein the first image is passed and the second image is blocked; and

(2) a second lens for the viewer's other eye comprising:

(a) third rotating means for selectively rotating the polarization of the light from the first image display output and the second image display output forming a second lens intermediate output; and

(b) a second linear polarizer for linearly polarizing the second lens intermediate output wherein the second image is passed and the first image is blocked.

15. A method of forming a patterned polarizer on a substrate comprising the steps of:

a. providing a birefringent retarder;

b. applying a layer of a photoresist to the birefringent retarder;

c. exposing and developing the photoresist; and

d. using the photoresist as a mask, selectively removing portions of the birefringent retarder.

16. The method according to claim 15 further comprising the steps of:

a. providing a linearizing polarizer;

b. applying a first layer of a transparent index matching adhesive to the linearizing polarizer

such that the birefringent retarder is affixed to the first transparent index matching adhesive.

17. The method according to claim 16 further comprising the steps of:

a. providing a transparent substrate; and

b. applying a second layer of a transparent index matching adhesive to the substrate

such that the linearizing polarizer is affixed to the second layer of transparent index matching adhesive.

18. A method of forming a patterned polarizer on a polarizer substrate comprising the steps of:

a. providing a linearizing polarizer;

b. applying a first layer of a transparent index matching adhesive to the linearizing polarizer;

c. affixing a first birefringent retarder to the first layer of a transparent index matching adhesive providing a retardation of $\lambda/2$ (half-wave) and thus rotating a polarization of the light by 90°;

d. applying a first layer of a photoresist to the birefringent retarder;

e. exposing and developing the first layer of a photoresist; and

f. using the first layer of exposed and developed photoresist as a mask for selectively removing portions of the birefringent retarder.

19. A method of forming a patterned polarizer on a polarizer substrate comprising the steps of:

a. providing a linearizing polarizer;

b. applying a first layer of a transparent index matching adhesive to the linearizing polarizer;

c. affixing a first birefringent retarder to the first layer of a transparent index matching adhesive having a first rotational sense;

d. applying a second layer of a transparent index matching adhesive to the linearizing polarizer;

e. affixing a second birefringent retarder to the second layer of a transparent index matching adhesive having a second rotational sense which is opposite and twice as large as the first rotational sense;

f. applying a first layer of a photoresist to the birefringent retarder;

g. exposing and developing the first layer of a photoresist; and

h. using the first layer of a photoresist as a mask, selectively removing portions of the second birefringent retarder.

20. The method according to claim 18 further comprising interposing the steps of affixing a barrier layer to the layer of a transparent index matching adhesive and applying another layer of a transparent index matching adhesive to the barrier layer before the step of affixing the birefringent retarder layer that is to be patterned.

21. The method according to claim 18 wherein the step of exposing further comprises using a mask for defining an area of exposure.

22. The method according to claim 21 wherein the mask is formed on an appropriate masking substrate by the steps of:

a. applying a second layer of opaque masking material to the masking substrate;
b. applying a second layer of a photoresist to the opaque masking material;
c. temporarily affixing the structure resulting from step b to a raster arrayed display screen having a plurality of pixels such that the second layer of a photoresist is toward the display screen;
d. selectively energizing a portion of the pixels to expose the second layer of a photoresist;
e. removing the structure from the display screen;
f. developing the second layer of a photoresist; and
g. selective removing a portion of the opaque masking material using the photoresist as a mask.

23. The method according to claim 18 wherein the epatterned polarizer is for a raster arrayed display screen having a plurality of pixels wherein the substrate is the display screen wherein the step of exposing the first layer of a photoresist comprises the step of selectively energizing a portion of the pixels to expose the first layer of a photoresist.

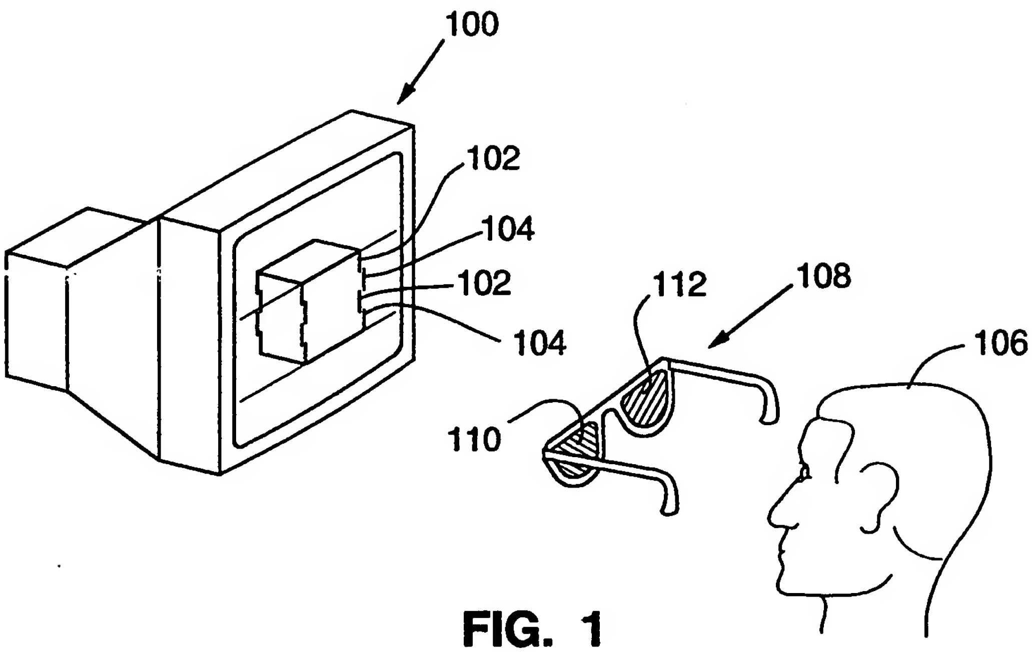

FIG. 1

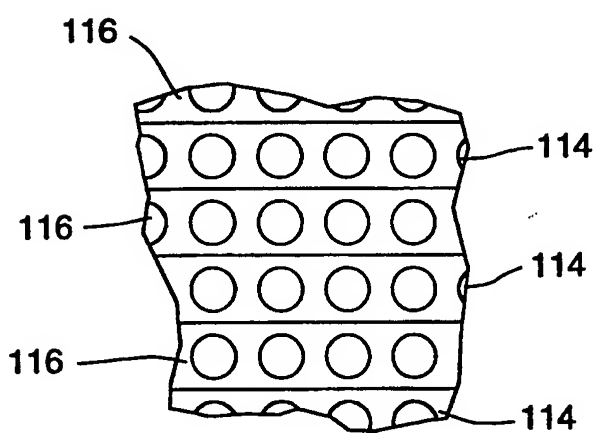

FIG. 2

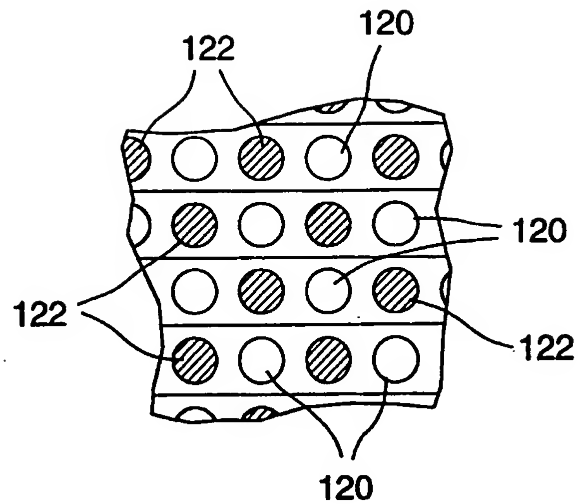
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FIG. 3

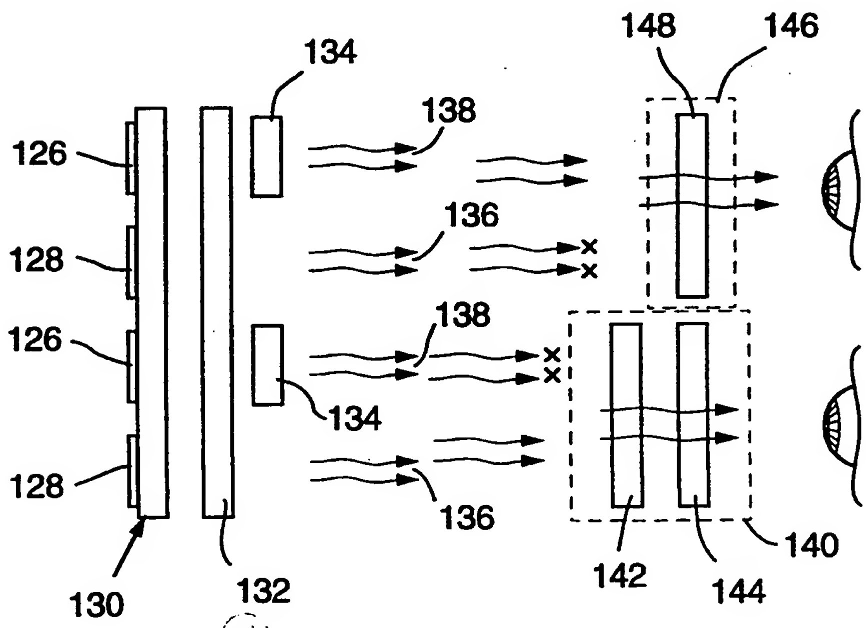
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FIG. 4

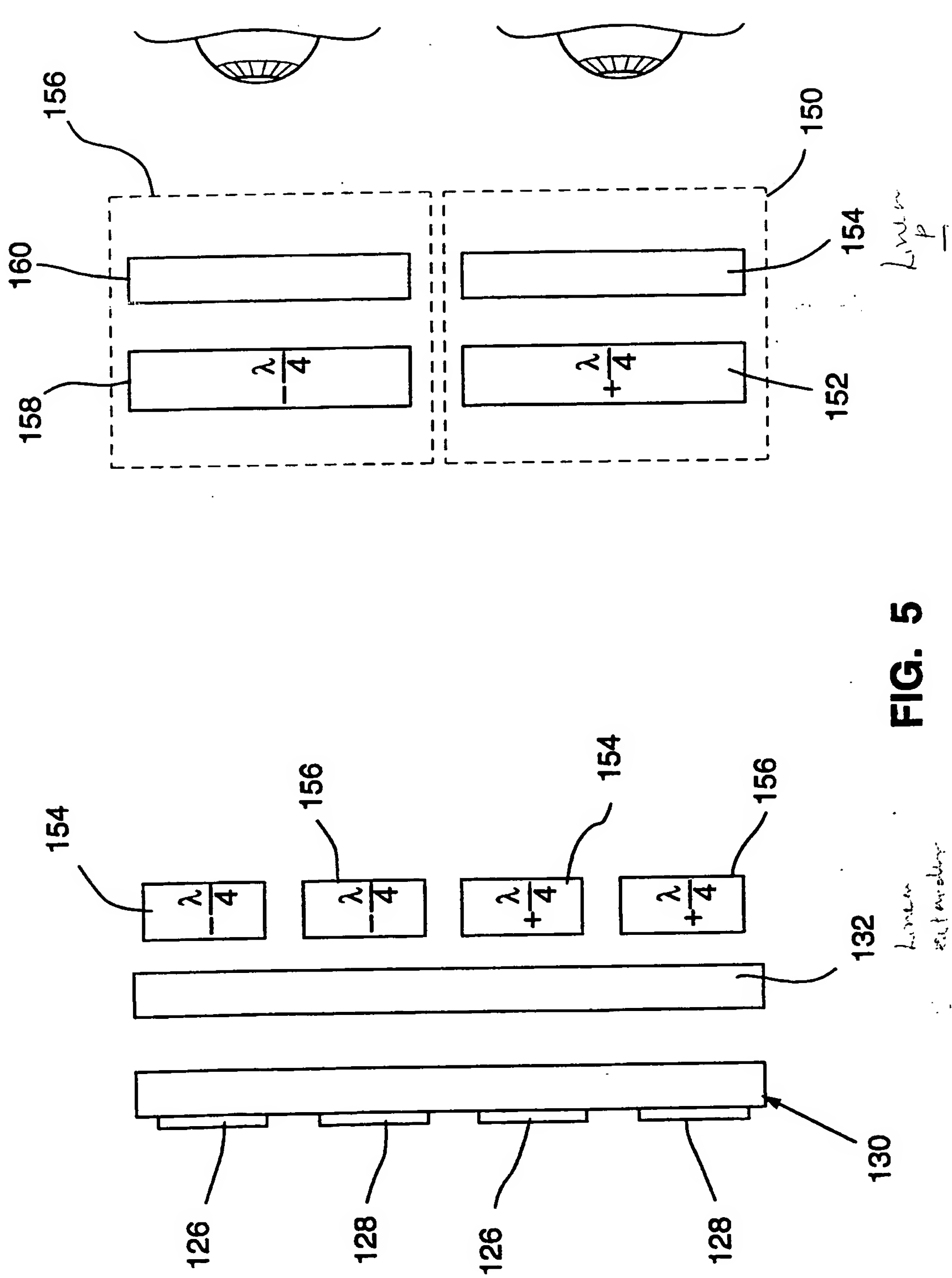
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FIG. 5

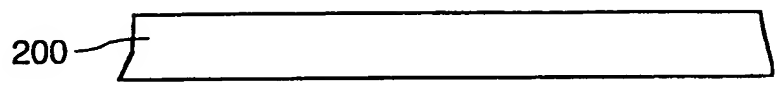

FIG. 6A

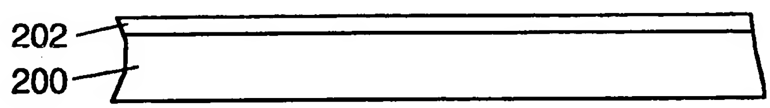

FIG. 6B

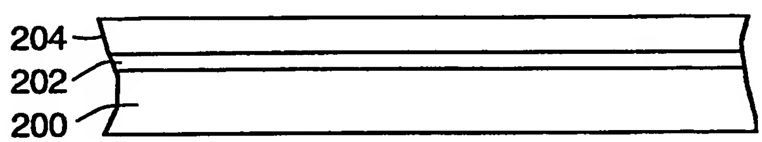

FIG. 6C

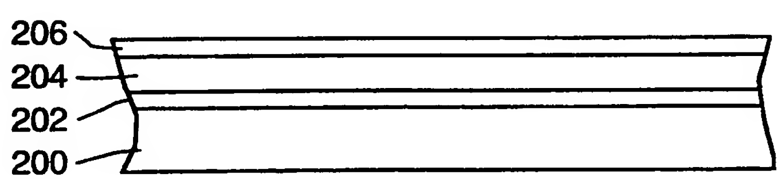

FIG. 6D

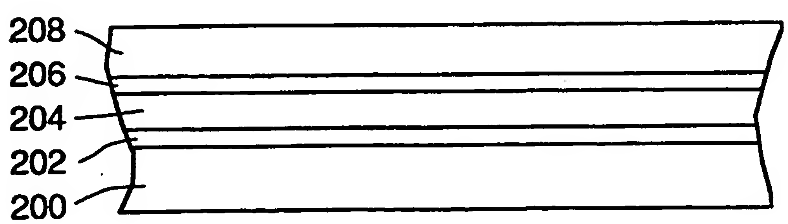

FIG. 6E

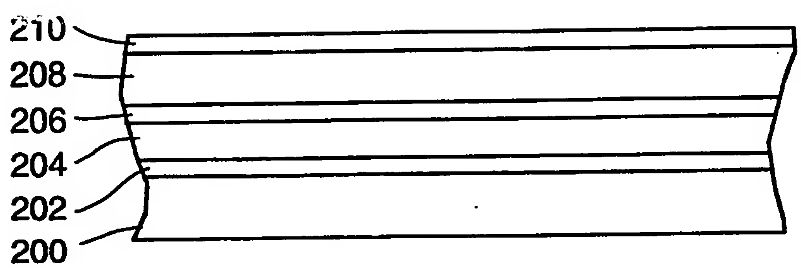

FIG. 6F

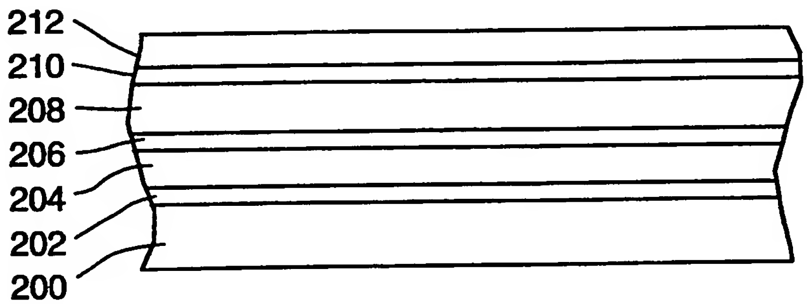

FIG. 6G

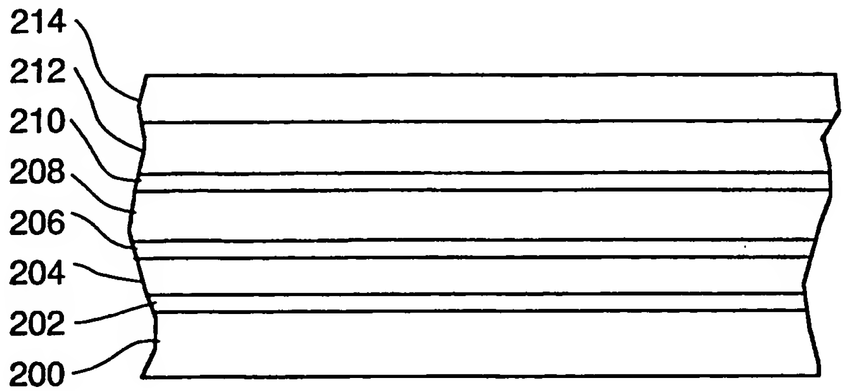

FIG. 6H

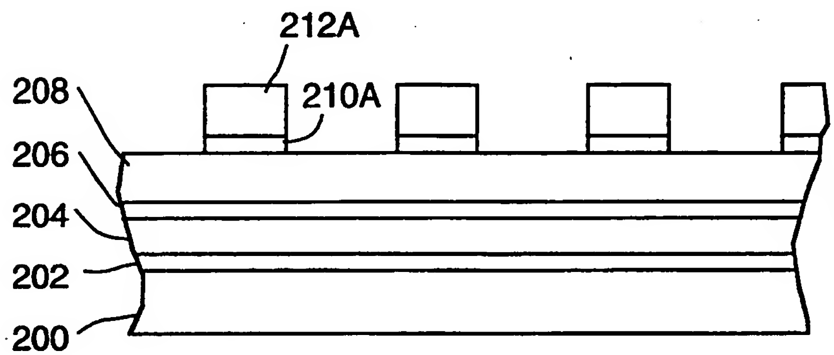

FIG. 6I

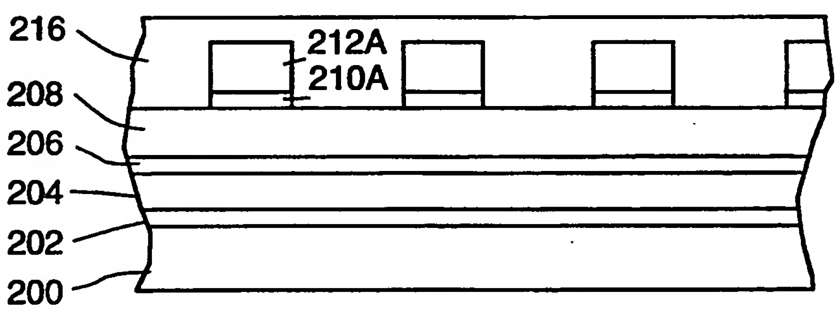

FIG. 6J

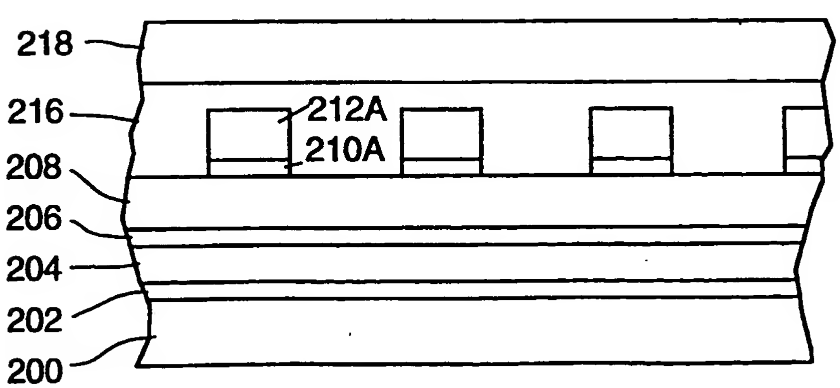

FIG. 6K

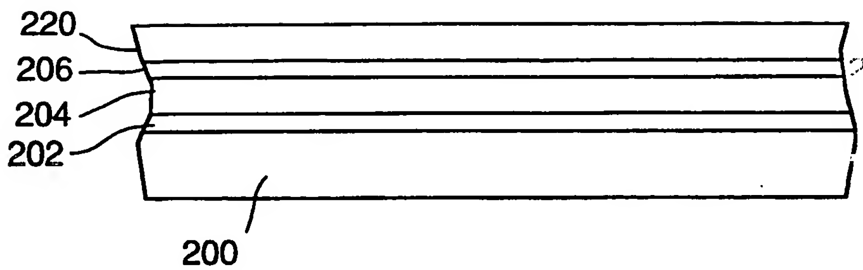

FIG. 7A

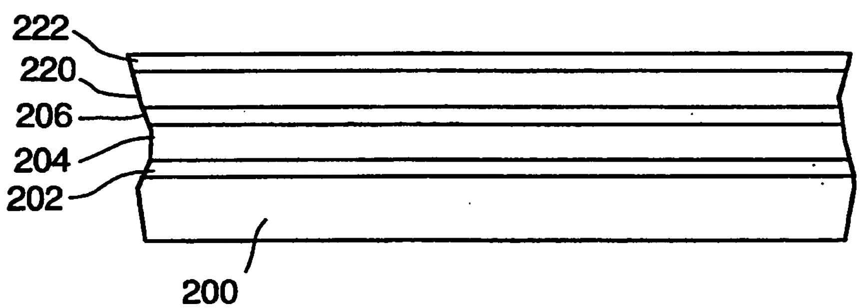

FIG. 7B

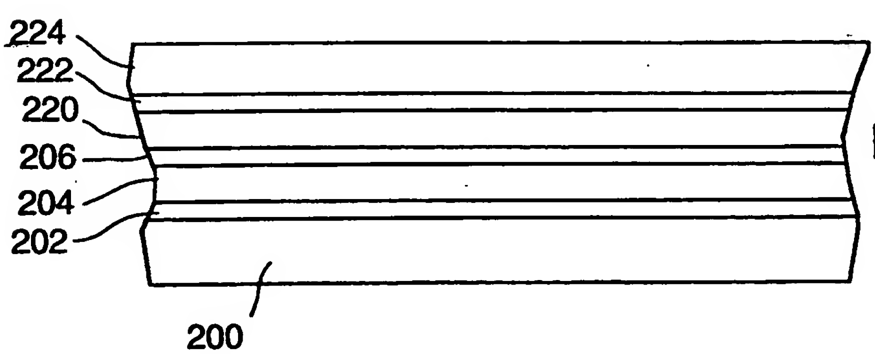

FIG. 7C

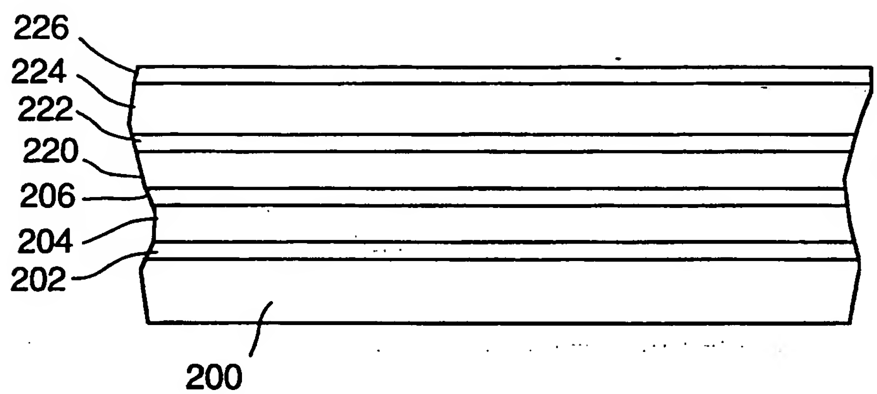

FIG. 7D

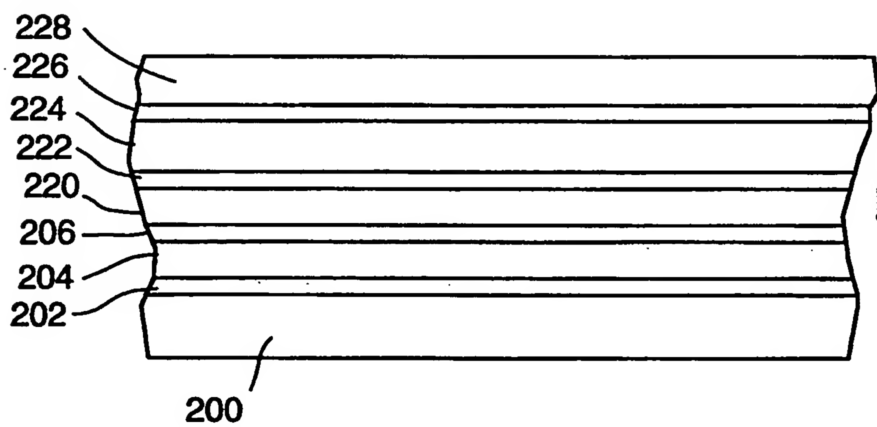

FIG. 7E

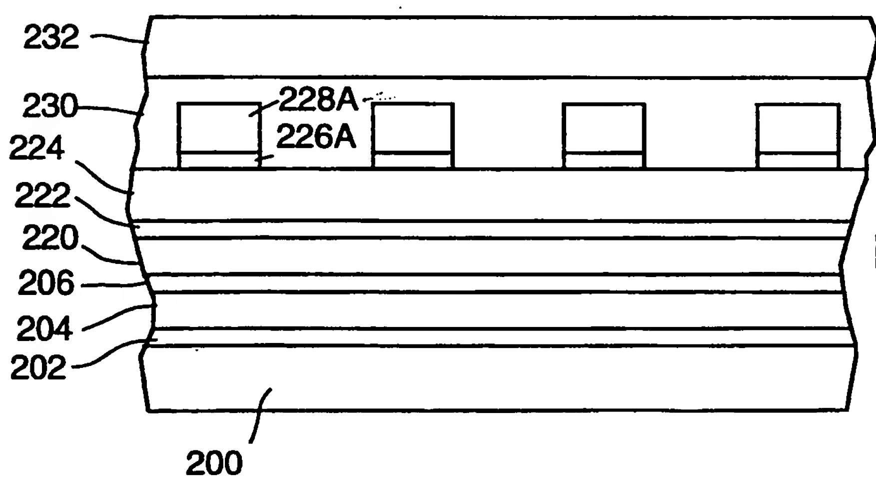

FIG. 7F

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US94/06853

A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) : G02B 27/26, 5/30
US CL :359/465, 497; 348/58; 430/4
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 359/465, 497; 348/58; 430/4

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X ---- Y	US, A, 5,113,285, (FRANKLIN EL AL.) 12 May 1992 (see entire document)	1-3,5,7,14 ---------- 1-14
Y	US, A, 4,719,507, (BOS), 12 January 1988, (see entire document)	1-14
Y	JP, A, 63-305323, (NAKAGAWA) 13 December 1988 (see entire document)	1-14

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search: 02 AUGUST 1994

Date of mailing of the international search report: 12 SEP 1994

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231
Facsimile No. (703) 305-3230

Authorized officer
JON W. HENRY
Telephone No. (703) 308-0956